CLAIMS

We claim:

1. In an audio encoder with a quantization loop, a method comprising:

reconstructing a block of spectral data quantized as plural quantization bands;

processing the reconstructed block of spectral data as plural critical bands according to an auditory model, wherein the plural critical bands are variable relative to the plural quantization bands with respect to one or more of number and position; and

measuring quality of the reconstructed block of spectral data.

2. The method of claim 1 further comprising:

before the quantization loop, applying a quantization matrix to the block of spectral data, thereby quantizing the block as the plural quantization bands;

quantizing the block of spectral data with a uniform, scalar quantization step size that is adjustable in response to one or more feedback criteria.

3. The method of claim 2 wherein the reconstructing comprises:

inverse quantizing the block of spectral data with the quantization step size; and

inverse weighting the block of spectral data by the quantization matrix.

4. The method of claim 2 wherein the one or more feedback criteria are based at least in part upon the measured quality and a bitrate criterion.

5. The method of claim 1 wherein the measured quality is a ratio between a noise pattern and an effective excitation pattern for the block.

6. The method of claim 1 wherein the reconstructing comprises an inverse multi-channel transformation.

7. The method of claim 1 wherein the measuring comprises applying a set of band weights for the block.

8. The method of claim 1 wherein the measuring comprises measuring quality for each of the plural critical bands of the reconstructed block of spectral data.

9. The method of claim 1 wherein the measuring comprises measuring quality for each of the plural quantization bands of the reconstructed block of spectral data.

10. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring audio quality of a block of spectral data, the method comprising:

in an iteration of a quantization loop,

reconstructing a block of frequency coefficients quantized as plural quantization bands;

processing the reconstructed block as plural critical bands according to an auditory model, wherein the plural critical bands are variable relative to the plural quantization bands; and

measuring quality of the reconstructed block.

11. The computer-readable medium of claim 10 further comprising:

adjusting quantization level as necessary to satisfy one or more loop criteria.

12. The computer-readable medium of claim 10 wherein the plural critical bands differ from the plural quantization bands in one or more of number and position

13. The computer-readable medium of claim 10 wherein the reconstructing comprises an inverse multi-channel transformation.

14. The computer-readable medium of claim 11 wherein the quantization level is a quantization step size, and wherein a quantization matrix and quantization band boundary matrix establishes the plural quantization bands before the iteration.

15. The computer-readable medium of claim 10 wherein the measured quality is a ratio between a noise pattern and an effective excitation pattern for the block.

16. The computer-readable medium of claim 10 wherein the block has a variable size, further comprising normalizing the block before the processing.

17. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring quality of plural blocks of audio data, wherein each of the plural blocks has one of plural available block sizes, the method comprising:

for each of the plural blocks of audio data,

normalizing the block; and

computing a quality measure for the normalized block.

18. The computer-readable medium of claim 17 wherein the plural blocks of audio data comprise plural transform blocks of spectral data.

19. The computer-readable medium of claim 18 further comprising:

before the computing, processing the normalized transform block according to an auditory model that includes temporal smearing.

20. The computer-readable medium of claim 18 further comprising:

before the computing, processing the normalized transform block as plural critical bands according to an auditory model, thereby normalizing band scale.

21. The computer-readable medium of claim 17 wherein the normalizing comprises normalizing block size of the block.

22. The computer-readable medium of claim 17 wherein the normalizing comprises normalizing amplitude scale of the block.

23. An audio encoder comprising:

a frequency transformer for transforming a time domain block of audio samples into a transform block of frequency coefficients, wherein the transform block has a transform block size selected from among plural available transform block sizes;

a program module for normalizing the transform block.

24. The audio encoder of claim 23 further comprising:

a measurer for computing a quality measure for the normalized transform block.

25. The audio encoder of claim 23 wherein the normalizing comprises normalizing block size and amplitude scale of the block.

26. The audio encoder of claim 23 wherein the frequency transformer applies a modulated lapped transform.

27. The audio encoder of claim 23 further comprising:

a modeler for processing the normalized transform block according to an auditory model that includes temporal smearing.

28. The audio encoder of claim 23 wherein the normalizing comprises for each frequency coefficient in the transform block, repeating the frequency coefficient by an expansion factor in the normalized transform block, wherein the expansion factor is proportional to ratio of maximum transform block size to the transform block size of the transform block.

29. In a computer system, a method for measuring audio quality comprising:

step for computing an effective excitation pattern for a block of audio data based at least in part upon a reconstructed audio excitation pattern for the block;

step for computing a noise pattern for the block; and

step for computing a quality measure for the block based at least in part upon ratio of the noise pattern to the effective excitation pattern.

30. The method of claim 29 wherein the step for computing the effective excitation pattern comprises:

step for computing the reconstructed audio excitation pattern;

step for computing an original audio excitation pattern; and

step for computing minimum of the original audio excitation pattern and the reconstructed audio excitation pattern for each of plural bands.

31. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring audio quality, the method comprising:

computing an original audio masking measure;

computing a reconstructed audio masking measure; and

computing an effective masking measure based at least in part upon the reconstructed audio masking measure and the original audio masking measure.

32. The computer-readable medium of claim 31 wherein the effective masking measure accounts for changes in masking in reconstructed audio due to suppressed or enhanced levels in the reconstructed audio relative to original audio.

33. The computer-readable medium of claim 31 further comprising:

computing a noise measure; and

computing a quality measure based at least in part upon a ratio of the noise measure to the effective masking measure.

34. The computer-readable medium of claim 33 wherein the effective masking measure is an effective excitation pattern for a block, and wherein the quality measure is a noise to excitation ratio for the block.

35. The computer-readable medium of claim 31 wherein a block includes plural bands, and wherein the effective masking measure is the minimum of the original audio masking measure and the reconstructed audio masking measure for each of the plural bands of the block.

36. In an audio encoder, a computer-implemented method comprising:

measuring quality of plural blocks of spectral audio data in an encoding session, comprising:

for a first block of the plural blocks, weighting a first quality measure with a first set of band weights; and

for a second block of the plural blocks, weighting a second quality measure with a second set of band weights different than the first set of band weights.

37. The method of claim 36 wherein the first set of band weights accounts for noise substitution by giving no weight to each noise-substituted band.

38. The method of claim 36 wherein the first set of band weights accounts for band truncation by giving no weight to each truncated band.

39. The method of claim 36 wherein the first and second sets of band weights are for quantization bands.

40. The method of claim 36 wherein the first and second sets of band weights are for critical bands.

41. The method of claim 36 wherein the quality measure is a band-weighted noise to excitation ratio.

42. The method of claim 36 wherein the first set of band weights differs from the second set of band weights in number of band weights.

43. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring audio quality, the method comprising:

computing a band-weighted audio quality measure for a block of frequency coefficients, wherein weighting compensates for noise substitution in one or more of plural bands in the block of frequency coefficients.

44. The computer-readable medium of claim 43 wherein the weighting compensates for noise substitution by giving no weight to each noise-substituted band.

45. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring audio quality, the method comprising:

computing a band-weighted audio quality measure for a block of frequency coefficients, wherein weighting compensates for band truncation in one or more of plural bands in the block of frequency coefficients.

46. The computer-readable medium of claim 45 wherein the weighting compensates for band truncation by giving no weight to each truncated band.

47. A computer-readable medium having encoded therein computer-executable instructions for causing a computer programmed thereby to perform a method of measuring audio quality, the method comprising:

for each of one or more blocks of frequency coefficients,

determining one or more arrays of band weights for the block, wherein the one or more arrays of bands weights are variable from block to block; and

computing a band-weighted quality measure, wherein the one or more arrays of band weights modify the quality measure.

48. The computer-readable medium of claim 47 wherein the one or more arrays include a first array of perceptual weights, a second array of noise-substituted band identifiers, and a third array of truncated band identifiers.

49. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for a pattern of the audio data.

50. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for available bitrate.

51. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for expected audibility of playback.

52. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for sampling rate.

53. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for user input.

54. The computer-readable medium of claim 47 wherein the determining includes varying the one or more arrays to account for audio application.

55. An apparatus comprising:

a multi-channel transformer operable to switch between plural channel modes including first and second channel modes, the first channel mode for outputting multi-channel audio data in jointly coded channels, the second channel mode for outputting the multi-channel audio data in independently coded channels; and

a program module for measuring quality of the multi-channel audio data in a channel mode-dependent manner.

56. The apparatus of claim 55 wherein the program module uses a first set of weights in measuring quality for jointly coded channels, and wherein the program module uses a second set of weights in measuring quality for independently coded channels.

57. The apparatus of claim 55 wherein the program module selects a representative quality from among measured qualities for channels of the multi-channel audio data for a given period.

58. The apparatus of claim 57 wherein the representative quality is a non-linear function of the measured qualities for the channels.

59. The apparatus of claim 57 wherein the multi-channel audio data is in stereo mode.